

coidal and spherical), and *Podocyrthis*. A few specimens of well-marked fossilized Dictyochidæ also occur. Both the Polycystina and the Dictyochidæ, as well as the mass of the loose granular material associated with them in the same flint-cavities, are more or less metamorphosed by a slight admixture of peroxide of iron and calcite, the former substance having imparted to the entire structures a bright reddish hue.

Through the courtesy of Prof. T. G. Bonney, F.R.S., I have been enabled to examine a slide of "diaspro" containing Polycystina. These, however, exhibit somewhat less of the characteristic structure of the organisms, owing, no doubt, to their having become fossilized under less favourable conditions than those which existed in the hermetically closed flint-cavities. In both cases the polariscope shows the silica to have been partially replaced by calcite.

I have likewise found in material obtained from hermetically closed flint-cavities, by far the most perfectly preserved Foraminifera I have ever seen, the shell-structure and chambers, with every minutest detail of tubular structure, having been converted into chalcedony—the whole mass by reflected light presenting a beautifully whitish-blue opalescent appearance, whilst by transmitted light it exhibits a rich transparent burnt-sienna colour and the well-known fibrous character of chalcedony wherever that substance is most massive, as, for instance, within the chambers. The Foraminifera represented belong chiefly to the genera *Rotalia*, *Globigerina*, and *Textularia*. I may add that, as regards perfection in every minutest detail of shell-structure, these specimens greatly surpass in beauty those metamorphosed into *glauconite*, beautiful as they also undoubtedly are.

IX.—*Notes on the Structure, Postembryonic Development, and Systematic Position of Scolopendrella.* By J. WOOD-MASON, Deputy Superintendent, Indian Museum, Calcutta.

THIS interesting and remarkable type of Tracheate Arthropoda was first made known to science in 1839*, in which year the distinguished zoologist Prof. P. Gervais brought to the notice of the Academy of Sciences at Paris some specimens of a small and fragile Myriopod which had been discovered in the vicinity of the French capital; and founded

* 'Comptes Rendus,' tome ix. p. 532 (1839).

upon them the genus *Scolopendrella*. This preliminary notice was followed in 1844* by a description with figures of the species under the name of *S. notacantha*, which description and figures were in 1847 † repeated in the 'Suites à Buffon.'

A second species was not long afterwards described and figured, from specimens obtained near London, by our own countryman Newport ‡, who at first thought the genus allied to the Chilopodous *Geophilus*, but eventually placed it in a family by itself between *Lithobius* and *Scolopendra*, notwithstanding that the fourth somite and its appendages are not developed into the basilar plate and poison-claws so characteristic of Chilopoda.

In 1851 a memoir §, which is far the most complete of any that have as yet appeared, was published by Menge on Newport's species *S. immaculata*. This author, who discovered the silk-glands that lie in the last two somites and open at the ends of the caudal appendages, as well as the tracheæ (which he did not, however, correctly interpret), and several other structural features of importance, regarded the genus *Scolopendrella* as "the type of a genus or family intermediate between the hexapod Lepismidæ and the Scolopendridæ;" but he refrained from making a new name.

Lubbock ||, Huxley ¶, and others have briefly referred to the genus.

I myself in 1876 ** recorded its occurrence in Bengal, and in 1879 †† published a few observations upon it and figured one of the legs.

In 1880 †† Mr. J. A. Ryder recognized in it "the last survival of the form from which insects may be supposed to have descended," and proposed for its reception "the new ordinal group Symphyla, in reference to the singular combination of Myriapodous, Insectean, and Thysanurous characters which it presents;" and in 1881 the same writer monographed the

* Ann. d. Sc. nat. Zool. tom. ii. 1844, p. 70, pl. v. figs. 15-17.

† Walckenaer et Gervais, Ins. Aptères, t. iv. pp. 301-303 (1847).

‡ Trans. Linn. Soc. Lond. vol. xix. pp. 373, 374, pl. xl. figs. 4, 4 a, b, c; and Cat. Myr. Brit. Mus.

§ "Myriapoden d. Umgegend v. Dantzig," in Neueste Schr. d. naturforsch. Gesellsch. in Danzig, iv. 4tes Heft.

|| 'Monograph of Collembola and Thysanura.'

¶ 'Anatomy of Invertebrated Animals.'

** Proc. Asiat. Soc. Bengal, August 1876.

†† "Morphological Notes bearing on the Origin of Insects," in Trans. Ent. Soc. Lond. 1879, p. 153, fig. 2, B.

‡‡ Amer. Nat. May 1880. The number of this publication for September of the same year contains a note on Ryder's communication, with some figures and suggestive remarks on *S. immaculata*.

group*, describing a new species, and giving a useful summary of Menge's important paper.

In 1881 † there appeared a paper by Dr. Jos. Muhr which is said to contain a valuable description of the mouth-parts of a new species closely allied to *S. notacantha*, but which I have not yet seen.

Finally, in the present year Dr. S. H. Scudder, of Cambridge, Mass., U. S. A., described a new species under the name of *S. latipes*.

I have arrived at the conclusion that *Scolopendrella* is a Myriopod which, while resembling the Chilopoda in the form of the body, is more nearly related to the Chilognatha; but whether it should be classed as a suborder of the latter or in an order by itself we shall be better able to say when we shall have learnt more about its anatomy and development than we at present know. And I regard it as the descendant of a group of Myriopods from which the Campodeæ, Thysanura, and Collembola may have sprung, looking upon the three latter groups as the living representatives of the extinct stock or stocks from which the various orders of insects have originated,—the jointed (Myriopodous) mandibles and the presence of two pairs of appendages (the one a pair of walking-legs and the other a pair of styli-form rudiments) on each of the two hinder thoracic somites, and of two pairs of rudimentary feet on each of two of the abdominal somites, in *Machilis* seeming to me explicable only on the hypothesis that this form is descended from an animal allied to the Chilognatha, and the somites of whose body were provided with two sterna, each furnished with a pair of appendages of the value of legs; and the resemblances of the true insects through *Blatta* to the Entomopsida (Campodeæ, Thysanura, and Collembola), on the hypothesis that the two have a common ancestry.

Seeing that there occur in combination in *Scolopendrella* two of the most remarkable features of *Peripatus*, namely two-clawed feet and segmental openings, its ancestry may be inferred to have lived and flourished before the present types of Myriopoda were evolved; and it may therefore throw much light on the origin of Myriopods also: it may, for example, afford an explanation of both the modes of addition of fresh segments—that which “takes place by the way of intercalation at each moult in the intervals between each pair of older segments,” and that by their interposition between the penul-

* Proc. Acad. Nat. Sci. Phil. 1881, pp. 79–86.

† Zool. Anz. iv. 1881, pp. 59–61, figs. 1, 2, and 4.

timate and antepenultimate somites—which obtain in Chilopoda, and of the nature of the double somites in Chilognatha.

The Head.—This is not so depressed as it is represented to be in the published figures, but is anteriorly deflexed, with the antennæ articulated to the forehead, much as in the Chilognathous Myriopoda. Its anterior margin is divided by a median notch into two rounded, thickened, and highly indurated lobes, each armed at the extremity with three sharp spiniform processes supported by buttress-like thickenings and directed with their fellows of the opposite side towards the middle line, thus recalling the sharp and toothed rostrum of Chilognatha.

On the upper surface of the head, behind the insertion of the antennæ, and in the same transverse line as the mandibular articulations, lie a pair of smooth and slightly convex areas with an exceedingly sharply defined and doubly contoured oval outline; they appear to be cake-shaped involutions of the integument; and their walls are covered with a minute punctation, which may possibly be the optical expression of the ends of fine canals. If a spirit-specimen of the animal be placed whole in a solution of hæmatoxylin for a few hours, these organs become filled, or their contents deeply coloured, by the reagent; so that they must freely communicate with the exterior. Whether they are glands, or stigmata, or eyes, can only be decided by means of sections; it would be worth while to compare them with the paired organs externally visible in the corresponding part of the head in *Glomeris* as conspicuous horseshoe-shaped impressions. Between these structures and the insertion of the antennæ I have not yet succeeded in making out the “round black eyes” which have been described by Menge; and it is possible that the two may be the same.

Previous observers have all recognized two pairs of jaws in addition to the mandibles, namely a pair of first maxillæ and a pair of second maxillæ, equivalent to the so-called labium of insects, but no other cephalic appendages; and they all appear to me to have misdescribed those that they have recognized.

I, on the contrary, see in the supposed two pairs of gnathites that succeed the mandibles but the coalesced parts of a single pair, resembling in all essential particulars the four-lobed plate that follows the mandibles and functions as a lower lip in the Chilognatha; and I have no doubt that the first pair of legs is the third pair of postoral appendages answering to the labium of insects.

First Pair of Postoral Appendages.—In specimens mounted

in spirits, with the dorsal surface upwards the mandibles are visible beyond the sides of the head, between the oval sacs above described and the insertion of the antennæ. They are therefore attached very far forwards; and their strong articulation is rendered very conspicuous by the amber-like colour of the cuticle, both of their posterior extremity and of the part of the head into which this fits—amber-like coloration indicating the great firmness of the chitinization that has taken place. They are divided by a very distinct joint, visible just in front of the insertion of the antennæ, into two segments: the first of these is a slightly curved prism attached to the head by its dorsal margin, and to the outer lobe of the four-lobed plate by its ventral margin, its inner side being consequently open, so as to give passage to the flexor muscles, which are inserted into the inner face of its outer wall; the second, a triangular plate, is armed on its inner side with two distinct series of teeth distinctly separated from one another by a rounded notch, the posterior series consisting of five small equal pale and blunt tubercular ones, and the anterior of four dark brown and highly indurated sharp teeth, of which the anterior and outer is slightly the largest, and lies in a different plane from the rest; from the bottom of the notch between the two series of teeth a faint groove encircles the joint, subdividing it into two, corresponding respectively to the first (which in *Glomeris* is developed on the inner side into an antero-posteriorly elongated molar process) and second or apical (which is bifurcate*) free joints in Chilognatha generally. The mandibles can be readily disarticulated from the head, as also can their two principal joints from one another. They are, in short, built exactly upon the plan of those of the Chilognatha, being divided into three distinct joints, and therefore not consisting, as has been stated, of a single piece only.

Second Pair of Postoral Appendages.—These are made up of seven or eight distinct sclerites, all united together by membrane, namely:—four lateral, of which two are long and

* The apical joint in all Chilognatha consists of two parts attached to a common base (the first free joint), but lying in different planes and applied to each other, much as are the "galea" and "lacinia" of the first maxillæ in such an insect as the common cockroach—an arrangement strongly suggestive of its being, like the jaws of *Peripatus*, a modified pair of claws. The objection to this is that all living Myriopods except *Scolopendrella* have the legs terminated by a single claw; and it would be fatal were it not that the legs of the Protracheata are biunguiculate. The ununguiculate condition of the legs in most Myriopods, in the larvæ of many insects, and in all the Collembola is probably adaptive.

anterior or apical, and two are short and posterior or basal; two median; and one or two basal. The two median sclerites are much broader than the long laterals; and they form together a broadly spatulate figure, which extends quite up to the toothed and lobed anterior margin of the head in front, and behind is divided into two divergent horns embracing the sides of the triangular basal sclerite. The long or apical lateral sclerites are attached not only to the medians and by the basal moiety of their outer margins to the ventral margin of the basal joint of the mandibles, but also by the inter-mediation of the short laterals to the basal part of the basal sclerite, which may be divided transversely into two parts; and they taper from their base to their apex, which reaches only to the end of the first mandibular joint and carries two large movably articulate appendages. These ordinarily lie with their apices all directed towards one another in the middle line, concealed beneath the rounded end of the conjoined median lobes; but when pressure is put upon the covering-glass they diverge and project straight forward for some distance beyond the front of the head*. They both lie in the same plane; and the outer (which is a highly indurated, slender, straight, and tapering organ, hooked at the extremity and provided internally with a minute anteapical spiniform process) fits the inner (which is a soft finger-shaped body with a brush of apparently implanted bristles on its inner extremity) as the "galea" does the "lacinia" in the first maxillæ of the cockroach—with which parts of the insectean maxillæ they can have nothing whatever to do, being plainly homologous with the two short and similarly convergent appendages that are present at the end of each outer lobe of the same pair of jaws in all Chilognatha, and being probably, like these and like the tips of the mandibles, modified pairs of claws inherited from the common Protracheate ancestor.

Third Pair of Postoral Appendages.—Of the fifteen dorsal sclerites which in adults follow the head, the first is little more than a mere short and transverse fold of skin with scarcely a trace of the conspicuous imbricating process given off from the posterior margin of all its successors; it is the tergum of the somite that bears the first pair of legs. These differ from those of the remaining eleven pairs in being conspicuously smaller and slenderer, with their last joint elongated, and their last but one shortened and apparently confounded with the third, in being more approximated at

* The fore margin of the median lobe also becomes protruded so as to display the six conical spines with which it is furnished.

their bases (where they are attached to two small oval sclerites nearly touching one another in the middle line), but above all in the important circumstance that they are never brought to the ground, but, on the contrary, are turned forwards under the head so as to be quite invisible from above in the living animal; commonly, indeed, they are folded akimbo across the under surface of the back of the head; they without doubt belong to the head, and they must, as they follow the four-lobed plate, be held to correspond to the similarly pediform and attached appendages of Chilognatha, and, as a consequence, to the labium of the Insecta.

The Somites of the Body and their Appendages.—The body of this little animal is extremely soft and fragile and extensible, and tapers visibly from the fourth leg-bearing somite towards the head, which is but little broader than the tergum of its hindermost somite. It is little, if at all, broader than high; and the soft membrane intervening on its sides between the leg-bases and the projecting lateral margins of the tergites is complexly puckered and folded in a manner reminding one of the Chilopoda. It is defended above by thirteen (exclusive of the caudal somite, which would appear to be double) imbricated plates or terga, whose hinder margin is divided by a pronounced emargination into two rounded lobes. In this series of terga no such regular alternation of longs and shorts as obtains in many Chilopoda is to be observed, nor equality, nor regular decrement or increment, but, on the contrary, a marked irregularity in length—an irregularity, however, which is identically the same in all the specimens hitherto examined.

On turning to the ventral surface, a consecutive series of eleven precisely similar regions, to each of which two distinct pairs of appendages are movably articulated, can readily be made out, or two less than the number of the terga opposed to them; consequently two of these must be without either appendages or sterna, or two of the somites must be considered to be provided with double terga. In each of these sternal regions two pairs of sclerites are discernible:—a posterior pair of nearly circular and smaller ones, which, without doubt, corresponds to the small and similarly shaped ones that carry the hindermost pair of cephalic appendages, and external to which a pair of stout five-jointed and biunguiculate legs are attached; and an anterior pair of elongated and larger sclerites, near to the postero-lateral margins of which, and between which and the legs, are articulated a pair of short setose styles.

This arrangement of the parts at once suggested the suspicion that each of the regions was made up of two sterna, each marked by a pair of appendages, the anterior and inner of which had become reduced to styli-form rudiments—a sus-

picion the correctness of which has been verified by the study of several stages in the postembryonic development of the animal. So that eleven pairs of rudimentary legs and eleven pairs of functional ones, or twenty-two in all, marking as many separate somites, are to be made out in this animal between the head and the tail.

The presence of the two apodous terga and of the eleven pairs of rudimentary feet seems intelligible only on the supposition that *Scolopendrella* has been evolved from a form with twenty-two distinct and complete leg-bearing somites, by the reduction to rudiments of the legs (accompanied by the abortion of the metamericly arranged organs, such as stigmata and excretory pouches of the somites), and the suppression of all but two of the terga of alternate somites.

The terminal tergum, which is longer than broad, truncated at both ends, and slightly arched at the sides, probably consists of two connate terga. It is converted posteriorly, apparently by the inbending of its sides, into a complete ring divided by vertical partitions into three compartments, to the two outer of which the perforated caudal appendages are attached, and into the median and dorsally emarginate one of which it is probable that the anus opens.

Between the complete ring formed by the posterior end of the last tergum and the last of the series of double sterna are interposed two plates, which I take to be the sterna of the last somite; of these the posterior, which extends beyond the extremity of the body, is soft and deeply cleft in the middle line; while the anterior, which is semicircular, and covers like an operculum all but the free margin of the posterior, is firmly chitinized and has its straight hinder margin entire. The postero-lateral margins of the latter are each produced into a short cylindrical process encircled with setæ and hollowed out at its extremity into a cup-like concavity, from a tubercle in the bottom of which springs an excessively long and fine and gradually tapering simple seta; this pair of setigerous processes, which have much more the appearance of rudimentary legs than of mere processes, especially in the larvæ, are probably sensory organs of some kind; whilst the aperture of the genital organs (which, according to Menge, to whom we are indebted for all our knowledge of the internal anatomy, open at the hinder end of the body) is probably situated in the former rather than in the anterior part of the body, where I have hitherto failed to make out any other openings but those I have described below.

Organs of Respiration.—These consist of eleven tracheal arches, opening by as many pairs of minute pores, situate on

the anterior faces of the leg-bases. If a moribund specimen be placed on its side under the microscope, a row of minute specks as bright as globules of quicksilver is seen, and remains visible until the contractions of the tissues consequent on drying have driven all the air from the tracheæ; and in specimens killed and discoloured by osmic acid, the stigmata, with the tracheæ running from them, are to be seen with the greatest distinctness, the latter being marked out by silvery streaks due to the presence of air. The tracheal tubes are all devoid from their very origin of the spiral thickening of their walls, so characteristic of the tracheæ of insects. Each of the stigmata leads into a tube which passes inwards, backwards, and upwards, slightly increasing in calibre as it goes, and meets its fellow of the opposite side in the middle line so as to form an arch; at the point where the tubes of opposite sides meet one another there is a slight blurriness or break in the continuity of the arch; and there is an irregularity in the height of the arches, to a certain extent corresponding to the irregularity in the length of the terga already noticed. No tufts of tubes appear to be given off from the arches; and I have not as yet made out in the body any other tracheæ besides these metamericly arranged ones. In the head, however, there are certainly tracheæ present; but I have not yet studied them sufficiently to be able to speak confidently about their arrangement and distribution.

The huge "crateriform openings," considered by Ryder to be the stigmata, have nothing whatever to do with the respiratory apparatus, the openings of which are excessively minute.

The respiratory apparatus of *Scolopendrella* consists, then, as far as it has yet been made out, of a series of eleven backwardly directed arches, opening by as many pairs of minute stigmata on the anterior faces of the leg-bases. If, in addition to the posterior arch, each pair of stigmata gave off an anterior arch, and every anterior were anastomosed in the middle line to a posterior arch, we should have an arrangement precisely similar to that which we meet with in the segmentally arranged portion of the tracheal system in such a Chilopod as *Geophilus*, in which a similar blurriness is to be seen at the points of anastomosis of the anterior and posterior arches.

? *Excretory Apparatus*.—Besides the stigmata, there is on every pedigerous somite, except certainly the first, and possibly also the second, eleventh, and twelfth, a pair of huge two-lipped apertures surrounded by a low circular wall, the summit of which is defended by a circlet of movable spines. They are in the round sclerites to which the functional legs

appear to be attached; and they therefore are posterior to the rudimentary legs. If a specimen be placed for a short time whole in a solution of hæmatoxylin, the everted mouths or the coagulated excreta collected upon these become deeply coloured by the reagent, so that the ventral surface of the animal is marked conspicuously with a double row of large round black-violet spots. An accident unfortunately happened to the specimen thus treated before I had had an opportunity of actually counting and noting down the number of openings that had been coloured; and I have been obliged to suggest that the round sclerites of the second, eleventh, and twelfth pairs of legs may be imperforate, though I fully believe that they are perforate like the rest. These openings possibly lead into glands which are homologous with the nephridia of *Peripatus* and with the glandular pouches of *Machilis* and *Campodea*; their exact morphological value is only to be determined by means of sections, which I hope shortly to have an opportunity of making. They are no doubt the apertures mistaken by Ryder for the stigmata, and which are stated by Scudder to be big enough to admit the tips of the legs.

Postembryonic Development.—Menge, according to Ryder's synopsis of his paper, met with a young animal provided with only eleven pairs of legs, and concluded that it was the first pair which was wanting; I, on the contrary, have never failed to recognize the first pair by its characters at any stage, and I am confident that it is one of those in possession of which the animal leaves the egg. Newport and Ryder both noticed "specimens of different ages with nine, ten, eleven, and twelve pairs of legs." I can confirm their observations, which prove that a pair of legs is added at each moult; and I have succeeded in making out the position of the germinal region.

In larvæ provided, in addition to the three-jointed first pair of legs which properly belong to the head, with seven pairs of rudimentary and seven pairs of functional legs, nine terga (exclusive of those which respectively carry the pediform third cephalic and the caudal appendages) are present, or two more than the number of double pairs of feet. It is difficult, owing to the manner in which the terga seem to have been thrown out of correspondence with their double sterna, to determine with certainty which these apparently apodous terga are; but they appear to me to be the fourth and seventh (the fifth and eighth if the third gnathites are reckoned in with the ambulatory legs) and the dorsal arcs of the somites to which the fifth and sixth pairs of rudimentary feet belong. A certain knowledge of this, as of many other points in the structure of

this interesting form, is only to be reached by carefully tracing the different stages of its development, step by step, from the egg. In larvæ of this stage the membranous interval between the bases of the last-formed (seventh pair) legs and the base of the setigerous penultimate sternum is found to be divided into two segments by a transverse groove; the anterior of these segments is by far the longer, and the posterior is very short: to the extreme outer ends of the posterior margin of the latter are attached a pair of conical processes constricted at their base; they are the buds of the future eighth pair of functional legs, and they lie wedged between the setigerous processes and the caudal appendages, below (but in the same vertical line with) which they are attached. From the posterior margin of the longer and anterior of these two fresh segments, but rather nearer to the middle line, two similar, but much shorter, conical processes arise and lie appressed to the surface of the setigerous sternum; these are the buds of the future eighth pair of rudimentary legs.

The addition of fresh somites therefore takes place in this animal by the intercalation of two at each moult between the antepenultimate and penultimate sterna, as in the Chilognatha, and as also in some of the Chilopoda, as far as some, at all events, of the somites are concerned, until the full number is attained.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

April 25, 1883.—J. W. Hulke, Esq., F.R.S.,
President, in the Chair.

The following communication was read:—

“On the Skull of *Megalosaurus*.” By Prof. R. Owen, C.B.,
F.R.S., F.G.S.

The specimens described in this communication were obtained by Edward Cleminshaw, Esq., from the freestone of the Inferior Oolite near Sherborne (Dorset) from some blocks which had been quarried for building-purposes. These were sent by him to the British Museum, where the remains have been developed. One block includes a great proportion of the right side of the facial part of the skull, the missing parts being the fore end of the premaxillary, the suborbital end of the maxillary, and the upper hinder pointed